

Northwestern Division - US Army Corps of Engineers
Anadromous Fish Evaluation Program
FY02 Research Summaries

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4. SBE-W-00-4
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5. SBE-W-00-5
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6. SBE-P-95-9
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7. SBE-P-00-17
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8. SBE-P-02-NEW
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Study of Causal Mechanisms of Fish Injury Within the Turbine Environment at McNary Dam.
2. OTS-W-01-1
Impacts to Adult Fish while Passing Through Turbines.
3. OTS-W-02-1 (New)
Estimation of "Total Turbine" Mortality (Direct and Indirect) for Juvenile Salmon and Steelhead.

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1. ADS-00-1
Evaluation of Adult Salmon and Steelhead Fallback at Snake and Columbia River Dams.
2. ADS-00-2
Evaluation of Adult Salmon and Steelhead Delay at Snake and Columbia River Dams.
3. ADS-00-3
Investigation of Unaccounted Losses in Adult Chinook and Steelhead Migrants.
4. ADS-00-4
Investigation of Straying and Wandering in Adult Salmon and Steelhead.
5. ADS-00-5
Temperature and Dissolved Gas Exposure of Adult Salmon and Steelhead Migrants and the Effects of Water Quality on Survival and Reproductive Success.
6. ADS-00-6
Evaluation of Kelt Passage through Columbia and Snake River Dams.
7. ADP-P-00-8
Development of Alternative Means to Pass Adult Pacific Lamprey Around Dams.
8. ADS-P-00-9
Effects of Swimming and Exhaustive Stress in Pacific Lamprey: Implications for Upstream Migration Past Dams.
9. ADS-P-00-13
Effects of Dam Passage on Survival and Reproductive Fitness of Adult Salmon and Steelhead.
10. ADS-00-14
Adult Salmonid Behavior and Passage Routes Within Adult Fishways Associated with the Adult PIT Tag Evaluations Program.
11. ADS-02-15 (previously objective 2 under ADS-00-3)
Evaluation of Adult Salmon and Steelhead 'Headburn' at Columbia and Snake River Dams.
12. ADS-02- (NEW)
Evaluation of Marine Mammal Predation Below Bonneville Dam.

Estuary (EST)

1. EST-02-1
A Study To Estimate Salmonid Survival Through The Columbia River Estuary Using Acoustic Tags.
2. EST-02-2
Estuarine Habitat And Juvenile Salmon – Current And Historic Linkages In The Lower Columbia River And Estuary.
3. EST-02-3
Evaluation Of The Relationship Among Time Of Ocean Entry, Physical, And Biological Characteristics Of The Estuary And Plum Environment And Adult Return Rates.
4. EST-02-4
Distribution And Abundance Of Coastal Cutthroat In The Columbia River Estuary.

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: BPS-W-00-1

TITLE: Re-Evaluate Juvenile Fish Facilities for Fish Passage Improvement.

FISH PROGRAM FEATURE: CRFMP – Juvenile Fish Facility Improvements (McNary, Lower Monumental, Little Goose, Lower Granite) and LMO Outfall Relocation

PROBLEM STATEMENT:

The juvenile fish facilities are currently being re-evaluated to identify problem areas in operation and reliability and to fish passage. As areas of improvement are identified and solutions developed biological evaluations may be necessary to ascertain that the improvements do not impact fish.

One such improvement is the relocation of the outfall release site at several of the juvenile fish facilities were not completely evaluated during the post-construction evaluation due to the logistical difficulties of fish recovery. At the time of construction this unknown was an acceptable risk because fish collected at the facility were destined for transportation. With recent changes in salmon management more fish are being returned to the river and the optimal site for outfall pipes is being reconsidered at Lower Monumental and McNary Dams.

Recent information from a BPA funded fall chinook survival study at McNary indicate that after release in the gatewells PIT tag fish hold periodically up to four days within the juvenile fish facility. In 2000 radio tagged chinook will be release with the BPA survival study to try and isolate the problem area.

BIOP MEASURES: This evaluation is included under Reasonable and Prudent Alternatives (RPA) 53, 76, 78, 81 and 95 in NMFS 2000 Biological Opinion for Operation of the Federal Columbia River Power System.

OBJECTIVES:

1. Evaluate current and potential outfall locations at Lower Monumental and McNary Dams (2002-2003)
 - a. Determine tailrace egress time, predation rates and immediate and downstream survival with respect to each outfall location.
 - a. Investigate the impact of the out-fall release velocities on injury and the short-term survival, and predator avoidance after release.
 - c. Investigate different (operational) bypass release times for improved post-bypass survival (reduction in predation).
2. Develop juvenile fish facility performance criteria based on fish condition. (2001)
 - a. Evaluate different methodologies used at the fish facilities to minimize stress (i.e. loading the raceways onto the barges).
 - b. Relate performance measures to accumulative stress, energy cost, and origin.
 - c. Correlate performance criteria to delayed mortality.
3. Evaluate juvenile fall chinook passage through the McNary fish facility to identify causes of holding within the facility. (2000-2002)

SCHEDULE: 2000-2004

SRWG COMMENTS 2000: Depending on the results of the McNary tagging Objective 3 is a placeholder. Objective 2 will be developed under the SCT Line Item for Snake River Juvenile Fish Facility Improvements. Objective 1 is awaiting the development of the LMO model.

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: BPS-W-00-2

TITLE: Water Temperature Effects on Juvenile Fall Chinook Salmon Survival at the Hydroprojects

FISH PROGRAM FEATURE: CRFMP - System

PROBLEM STATEMENT:

Hydro management has changed thermal regimes in the Snake River basin from that historically encountered under free-flowing conditions. An altered thermal regime in the main-stem Snake River have altered the life-cycle timing of ESA-listed Snake River fall chinook. The combination of these changes (such as a shift of spawning times, emergence times and growth rates) contribute to relatively low survival rates for juvenile summer migrants. As a result fall chinook outmigrate later in the summer when flows are low and water temperatures approach the lethal maximum. Since temperature drives many biological processes in fish, smolt physiology and performance may be compromised by chronic exposures to thermal stress. Disease susceptibility also increases with temperature. As a result, indirect temperature effects may cause substantial extra and delayed mortality to smolts passing through the juvenile bypass and collection facilities. Mortality may also increase with the added stress of transport or by having migration-prolonged in-river when conditions are poor. Evaluating the thermal effects on both migratory scenarios will provide information to improve the survival of juvenile fall chinook salmon.

BIOP MEASURES: This evaluation is included under Reasonable and Prudent Alternatives (RPA) 85, 141, 142 and 143 in NMFS 2000 Biological Opinion for Operation of the Federal Columbia River Power System.

OBJECTIVES:

1. Identify physiological indicators of acute and chronic thermal stress.
2. Identify performance-related changes of juvenile fall chinook salmon exposed to long-term sub-lethal temperatures and correlate to thermal exposure during dam passage.
3. Compare the physiological indicators of thermal stress and performance of in-river migrants and fall chinook salmon in the transportation system. (2001-2003) (McNary 2001, LGR 2002 and John Day 2003)
4. Estimate mortality of juvenile fall chinook resulting from the current range of temperature during in-river migration, bypass and transportation.

SCHEDULE: 2001-2004

NOTES: During the development of the research objectives for FY00 SRWG the Bypass Sub-group identified this as new and important work.

SRWG COMMENTS 2000: Water Temperature and Flow Augmentation are important issues that need to be developed. To accomplish this a sub-group of the SRWG will meet to discuss the issues and develop a prioritized study plan.

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: BPS-W-00-3

TITLE: Cylindrical Dewatering Screen Evaluation

FISH PROGRAM FEATURE: CRFMP-Cylindrical Dewatering Screen

BIOP MEASURE: RPA 20.

A cylindrical dewatering screen has been recommended for construction at the new Lower Granite Juvenile Fish Facility and McNary facility. The new screen design should reduce the debris blockage problem while maintaining dewatering screen criteria. The primary goal of the cylindrical dewatering screen is to reduce the frequency of screen blockage and failure during high debris events and to reduce fine debris from becoming imbedded within the dewatering screen. Second to dewatering performance under debris load, the cylindrical dewatering screen will be designed to provide an avenue for removing some debris from the system. A prototype cylindrical dewatering system is being constructed at McNary in 2000.

BIOP MEASURES: This evaluation is included under Reasonable and Prudent Alternatives (RPA) 94 and 96 in NMFS 2000 Biological Opinion for Operation of the Federal Columbia River Power System.

OBJECTIVES:

1. Evaluate the effects of test conditions established by the hydraulic performance tests of the prototype cylindrical dewatering system on the passage of juvenile fish (chinook including fry, steelhead and sockeye, and lamprey).
 - a. Evaluate the structure for biological effects; including descaling, stress, injury and passage rates.
 - b. Evaluate biological effects under a range of operations; including high debris loads.
 - c. Investigate solutions to holding behavior and other problems associated with the transition entering and exiting the cylindrical component.
2. Evaluate the debris removal efficiency of the cylindrical dewatering screen under a range of operations.
 - a. Determine impacts of debris flights on fish condition and debris removal.

SCHEDULE: 2000-2002

NOTES: This evaluation is linked to the juvenile fish facility proposed for construction at LGR and the Debris Control Program.

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: BPS-W-00-4

TITLE: Evaluate the Effects of Passage through the Juvenile Bypass Facilities and Reservoirs on Survival of Juvenile Pacific Lamprey.

FISH PROGRAM FEATURE: CRFMP – Bypass

PROBLEM STATEMENT:

Based on counts of adult lampreys in the fishways and anecdotal observations of abundance of lamprey ammocoetes in juvenile fish facilities, lamprey numbers appear to be in decline. Little is known about the effects of passage through juvenile bypass facilities on juvenile Pacific lamprey.

BIOP MEASURE: NA

OBJECTIVES:

1. Establish migration characteristics and run timing at Snake and Columbia river dams. (2002)
2. Obtain baseline information on the current abundance, and horizontal and depth distribution of juvenile Pacific lamprey at the hydroprojects. (2002)
 - a. Determine lamprey spawning and rearing habitats near the confluence of tributaries affected by the potential operations (including drawdown) of the FCRPS. (2002)
 - b. Evaluate the effects of different project operations (including dam removal) on those habitats. (2002-2003)
3. Determine passage routes through the hydro-projects for juvenile Pacific lamprey.
 - a. Evaluate the effects of the juvenile fish facilities and project operations on passage rate, injuries and route specific survival. (2002)
 - b. Evaluate facility improvements for lamprey. (2002-2004) (including PIT tag diversion systems)

SCHEDULE: 2001-2004

NOTES: Lamprey survival is considered a high priority by CRITFC. This work has BPA overlap. Review Facility reports to determine impacts and needs.

SRWG COMMENTS 2000: One recommendation was to consolidate all Lamprey Objectives into a separate research topic/subgroup (for example, the lamprey objective under the John Day screens should be moved to this research summary). A study plan needs to be developed.

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: BPS-W-00-5

TITLE: Post-Construction Evaluation of the Modified PIT Tag Diversion System and Bypass at Little Goose dam

FISH PROGRAM FEATURE: CRFMP - Bypass

PROBLEM STATEMENT: The PIT tag diversion and bypass system at Little Goose dam was installed after the construction of the main juvenile fish facility to facilitate the monitoring of fish used in research. Since installation, problems with the PIT tag retrofits to the facilities have caused fish; holding, delays, lower detection efficiencies and possibly impact the condition of the fish. To install the best known passage condition for juvenile salmon diverted through this system, the head tanks and the four-inch electronic counting tunnels will be removed and replaced with a flume from the PIT tag diversion to the PIT tag switch gate. These modifications will be complete by the beginning of the 2002 juvenile salmon outmigration.

BIOP MEASURES: This evaluation is included under Reasonable and Prudent Alternatives (RPA) 74 and 81 in NMFS 2000 Biological Opinion for Operation of the Federal Columbia River Power System.

OBJECTIVES:

1. Evaluate modifications to confirm passage performance including; determine descaling and injury rates, identify areas where holding and other stressors may occur, and compare primary bypass survival to PIT tag diversion bypass survival. (2001-2002)
2. Determine PIT tag diversion efficiency and accuracy. (2001-2002)

SCHEDULE: 2001-2002

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BPS-W-00-6

TITLE: Evaluation of Debris Control Measures at Snake and Columbia River Dams

FISH PROGRAM FEATURE: CRFMP - Debris Control (also, Little Goose Trash Boom and McNary - Trash Boom and VBS Debris)

BIOP MEASURE: RPA 15.2, 19 and ITS 7

Installation of extended length diversion systems have provided improved fish passage benefits by increasing the numbers of fish diverted from the turbines to a bypass facility. However, the increased efficiency in fish guidance has also increased the amount of debris that is also diverted. Debris entering the bypass, collection and transportation facilities causes impacts to the normal operation. Debris problems at each hydroproject are unique. McNary has experienced blocked vertical barrier screens, which has resulted in unit outages during critical periods of the juvenile outmigration. In addition to blockage problems and screen failures, debris in the primary dewatering system have also impacted facility operations at McNary. Little Goose has been plagued by multiple incidences of debris blocking the orifices which increases the risk of injury and mortality to outmigrating smolts and unit outages during debris cleaning which in-turn resulting in higher levels of spill and increased dissolve gas levels downstream. Debris in the system has the potential to create problems throughout in the collection system from the extended length screens, gatewells, orifices, and dewatering structures to problems at the fish facility in the separator, raceways and sampling / loading / diversion systems.

BIOP MEASURES: This evaluation is included under Reasonable and Prudent Alternative (RPA) 79 in NMFS 2000 Biological Opinion for Operation of the Federal Columbia River Power System.

OBJECTIVES:

1. Evaluate the effect that the installation of trash booms in the forebay of the hydroproject has on juvenile salmon predation.
 - a. Determine baseline information on the forebay distribution and abundance of predators prior to trash boom installation (McNary placeholder)
 - b. Evaluate the re-distribution of forebay predators after installation of a forebay trash boom. (McNary placeholder)
 - c. Post-installations impacts of smolt distribution and forebay guidance (added at the SRWG 2000 meeting) Effects on vertical fish distribution (1st year)and FGE (2nd year).
2. Evaluate debris management concepts, including operational and structural changes. (Placeholder)

SCHEDULE: 2000 - 2002

NOTES

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: BPS-W-00-8

TITLE: Enhance Separator Performance and Prototype Separator Evaluation

FISH PROGRAM FEATURE: CRFMP-System-Separator Evaluation

Separation of different species of smolts from one another at the transportation projects is being conducted in an effort to provide a less stressful holding environment for the smaller species during transportation process and to allow different in-season management options for the benefit of each species. Separator designs have been incrementally improved through development and construction of each state-of-the-art fish facility (McNary, Ice Harbor, Lower Monumental, and Little Goose Dams). However, separation efficiencies of the present day separators are highly variable (for yearling chinook ranging between 44 to 75% at Little Goose, 38 to 65% at Lower Monumental and 35 to 60% at McNary) and have not achieved the efficiencies (~80% for yearling chinook) of the original prototype.

Previous investigations of a wide range of concepts to improve separation (including secondary separation, attraction flows, lights and other visual queues) have narrowed the focus of work to two major concepts: an improved existing style separator and high velocity flume separation. These concepts have been identified as having the greatest potential for meeting ideal separation performance. An improved existing style separator was recommend for evaluation to operate within similar dimensions and hydraulic demands as the separators currently in use at the juvenile fish facilities on the Snake River and at McNary Dam. A high velocity flume separator, the second concept utilizes the diving behavior of fish that has been commonly observed (and documented by work conducted in 1997 - 1999) in a high velocity environment and eliminates the hydraulic conditions found within the existing style separators that create velocity barriers. These unique characteristics have the potential of being developed into a style of separator with increased separation efficiency, passage time, and lower stress along with increased capabilities for rapidly removing adults from the system and handling debris.

BIOP MEASURES: This evaluation is included under Reasonable and Prudent Alternative (RPA) 95 in NMFS 2000 Biological Opinion for Operation of the Federal Columbia River Power System.

OBJECTIVES:

1. Evaluate performance of the improved existing style separator in an operational separator based on the improvements from the "existing style separator prototype". These include supply water orientation; tank configuration; exit shape, alignment, and elevation; separator bar configuration and spacing. (2002)
2. Finalize the evaluations of secondary variables in the high velocity flume separator at Ice Harbor prototype (based on 2000) that can be incorporated into concurrent design. (2001)
 - a. Post-Construction evaluation of constructed separator. (2003-2005)
 - b. Investigate application of secondary separation to improve performance of separation (dependent on separator performance).

SCHEDULE: 2000-2004

COMMENTS SRWG 2000: Modification of an existing separator (Objective 1) is considered high at LMO but it should be noted that with the design problem associated with the flume may cause problems with the study results, therefore McNary may be a better research site.

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BPS-00-9

TITLE: Evaluate Comparative Survival of In-River Passage to Multiple Bypassed Juvenile Salmon.

FISH PROGRAM FEATURE: CRFMP – System - Bypass

PROBLEM STATEMENT:

Adult return data from the PIT tag marked juvenile chinook indicate that fish bypassed multiple times around the dams may be returning at a lower rate than fish that remain in-river. However, this data set is subject to several problems including small sample size, sample set dependent relationship, poor secondary bypass routes, and a lack of sufficient downstream PIT tag detection sites. Preliminary physiology data suggests that there may be problems associated with long term survival of bypassed fish compared to in-river and transportation passage.

Two major ways that bypass systems have been proposed to effect survival and adult return rates are through indirect mortality. The first assumption is that the process of bypass guides or changes fish of a specific physiology or behavior that results in higher mortality later in the system. The second suggested cause is by direct or near term mortality caused by site specific problems with one or more bypass facilities. While returns from bypassed fish at Lower Granite and Little Goose dams remain high, site specific problems have been identified at Lower Monumental and McNary dams (See Note section).

Delayed or indirect mortality caused by passage through the bypass systems has been attributed to three possible causes. 1) Fish experience a physiological change as they pass through multiple bypass systems. 2) Fish guidance systems guide some fish better than others, particularly those with a pre-existing condition (genetic or physiological) that also results in higher delayed mortality than fish not selected by the guidance system. 3) Bypass systems disrupt the natural, interactive behavior of groups of fish by breaking up large schools into small groups or individuals. It has been suggested that a cohort of fish passing through the hydrosystem exhibits a characteristic behavior (schooling) as a unit that offers higher survival to school members than to individual fish. Although it is unknown if this specific behavior occurs, the potential benefits offered by the group as opposed to individuals should be correlated to route of passage.

BIOP MEASURES: This evaluation is included under Reasonable and Prudent Alternatives (RPA) 46, 47, 103,104, 186, 189 and 195 in NMFS 2000 Biological Opinion for Operation of the Federal Columbia River Power System.

OBJECTIVE:

1. Determine the comparative survival of juvenile and adult returns of bypassed and in-river migrating chinook and steelhead.
 - a. Investigate the feasibility of enhancing the sample sizes of pre-existing studies.
 - b. Review historical data to assess survival and adult returns of multiply bypassed fish and in-river migrants.
2. Monitor and compare differential recovery of multiple bypassed fish downstream of the hydrosystem.
 - a. Monitor within the estuary with the PIT tag trawler.
 - b. Recovery of PIT tags from the avian islands in the estuary and river system.
3. Compare physiological differences in fish multiple bypassed to fish from a first time bypass.
4. Continue to evaluate site specific problems in the bypass facilities (See Notes).
 - a. Partition survival / mortality between Lower Monumental and McNary.
 - b. Continue Lower Monumental facility evaluation.
 - c. Partition Ice Harbor survival / mortality
5. Determine delayed mortality of fish multiply bypassed to in-river migrants. (See Notes).

SCHEDULE: 1999-2003

NOTES:

- A. The evaluations of site specific problems are identified under the research summary, *Re-Evaluate Juvenile Fish Facilities for Fish Passage Improvement, Objectives. Comparative survival of bypass systems (primary, secondary, emergency and PIT tag diversion) and outfall pipe re-assessment.*
- B. The evaluation of differential delayed mortality is identified under the research summary, *Evaluate Comparative Delayed Mortality of Juvenile Salmon Utilizing Different Routes of Passage.*
- C. The information on comparative survival was considered important by the SRWG sub-groups on In-River Passage, Bypass Systems and Transportation.

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: BPS-00-10

TITLE: Evaluate Comparative Delayed Mortality of Juvenile Salmon Utilizing Different Routes of Passage at the Dams on the Lower Columbia and Snake River System.

FISH PROGRAM FEATURE: CRFMP – System - Bypass

PROBLEM STATEMENT

Much of the post-hydrosystem mortality has been attributed to passage through different routes of passage at the dams (spill, bypass systems, turbines, surface collection and transportation). Although this concept has been assumed based on the return data from the juvenile salmon transportation data and the multiple bypass data compared to in-river migrants. Juvenile chinook transported through the hydrosystem survive at a higher rate compared to in-river migrants. Yet if equal post-system mortality is attributed to both groups of juveniles the transportation release group should be returning at a higher rate.

The question concerning differential rates of survival (or delayed mortality) in the ocean environment and how they correlated through time and route of passage has become one of the key unknowns facing future decisions regarding construction of passage systems for fish.

BIOP MEASURES: This evaluation is included under Reasonable and Prudent Alternatives (RPA) 47, 49, 186, 187, 189 and 195 in NMFS 2000 Biological Opinion for Operation of the Federal Columbia River Power System.

OBJECTIVE:

1. Determine the comparative post-system delayed mortality of juvenile fish passed through bypass systems, spillways, surface bypass, or transportation.
 - a. Determine temporal scale of mortality within and downstream of the hydrosystem.
 - b. Determine near term mortality of fish with known passage histories. Recover PIT tagged fish with different passage histories and rear several months to determine differential mortality rates between the passage groups. (Incremental partitioning of mortality of fish with known passage histories through time.)
 - c. Determine differential mortality attributed to stock.
2. Partition mortality in the hydrosystem and correlate to route of passage.
 - a. Determine direct versus indirect mortality
 - b. Determine extra mortality
 - c. Determine physiology and disease related mortality
 - d. Determine rate of passage and survival through the estuary and saltwater interface.
 - e. Conduct bioassays of juveniles recovered from bird colonies to determine differential predation rates based on fish condition and route of passage.

SCHEDULE: 2000-2004

NOTES:

- A. This work is closely related to the comparative survival studies of multiple bypass, in-river passage and transportation
- B. This issue was considered important by the In-River Passage, Bypass Systems, and Transportation sub-groups of the SRWG.

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: BPS-00-11

TITLE: Evaluate the Migration Behavior of PIT-Tagged Juvenile Salmonids in the Estuary

FISH PROGRAM FEATURE: CRFMP-System

PROBLEM STATEMENT:

Relative abundance, timing, migration behavior and survival of juvenile salmonids passing through the estuary and near shore ocean environments are poorly documented. This knowledge is important to the understanding of the relationship between post release (and in-river migrating) mortality of juvenile salmonids in the estuarine and oceanic environment.

BIOP MEASURES: This evaluation is included under Reasonable and Prudent Alternatives (RPA) 197 in NMFS 2000 Biological Opinion for Operation of the Federal Columbia River Power System.

OBJECTIVES:

1. Confirm performance standards of the new system for the ISO PIT tag. (2000)
2. Assess relative abundance and timing, and migration patterns through the estuary and near shore ocean environment of PIT-tagged juvenile chinook salmon release for the evaluation of transportation and in-river migration from Lower Granite Dam, McNary, and other release groups where applicable. Verification of migration behavior, relative differences in species composition, abundance, depth, and location. (2000 – out years)
 - a. Continue recovery of chinook salmon
 - b. Recover steelhead and fall chinook
3. Recovery of PIT tags from bird colonies in the estuary and river system.
4. Determine differential predation on juveniles salmon.
 - a. Correlate to seasonal variation.
 - b. Correlate mortality to fish condition, route of passage, origin and know stocks.

SCHEDULE: 2000 plus (Additional years are dependent on the years of transportation, or survival studies using large groups of PIT tagged marked fish.)

NOTES:

- A. This work has been identified as a critical element under the comparative survival studies, delayed mortality.
- B. This work will be coordinated with future radio tracking work in the estuary and avian predation evaluations.

This work was supported by the Bypass Systems and Transportation sub-groups of the SRWG.

**Northwestern Division- Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: BPS-P-00-14

TITLE: B2 FGE

FISH PROGRAM FEATURE: CRFMP-Bonneville -Powerhouse 2 FGE

BIOP MEASURE: RPA 67. The current downstream migration system at the Second Powerhouse consists of a submersible travelling screen system (STS) employed to guide juvenile salmonids up into the gateway slot, bypassing the turbines to a release point approximately 2 miles downstream of the project. After initial start up in the early 1980's, the bypass system was tested and found to have low guidance efficiencies (FGE) for all target fish. As part of an extensive multi-year research and development program, turbine intake extensions, streamlined trashracks, and lowered STS were installed which significantly improved FGE for spring migrants. However FGE for yearling and subyearling migrants remains unacceptably low, 45-60% and 20-25% respectively. In 1999 we reviewed past work, developed alternatives and prepared outyear plans and cost estimates. The resulting program uses a phased approach to addressing hypotheses presented by the 1999 work. Initial effort will focus on the intake environment. For FY00 we measured vertical distribution upstream and within two intakes, and estimated FGE across all units. We also initiated a hydraulic modeling program to develop a prototype intake screen system. In 2001 we plan to field test a prototype screen system at Powerhouse 2. Depending on 2001 results, this system may be evaluated again in 2002.

OBJECTIVES:

- 1) Evaluate the effectiveness of a prototype intake screen system for both spring and summer juvenile salmonid migrants (*placeholder for 2002*):
 - a. Determine FGE
 - b. Determine condition of fish collected from a gateway of the prototype unit
 - c. Compare survival and condition between different passage routes: prototype gateway, collection channel, and STS gateway
 - d. Determine orifice passage efficiency
 - e. Determine gateway retention time
- 2) Assess the effect of a prototype intake screen system on juvenile salmonid fry passage (*placeholder for 2002*).

SCHEDULE: 2000 – 2003

NOTES:

**Northwestern Division- Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: BPS-P-00-15 (formerly MPE-P-96-3)

TITLE: Evaluations of the Modified Extended Length Submersible Bar Screens (ESBS) at the John Day Dam

FISH PROGRAM FEATURE: CRFMP-John Day Dam-Extended Screens

PROBLEM STATEMENT: Fish guiding efficiency (FGE) for subyearling chinook salmon at the John Day Dam is approximately 26%, calculated using the standard length STS'. In 1996, prototype ESBS were evaluated for FGE, orifice passage efficiency (OPE) and fish condition. Significant improvements were documented for each evaluation with the ESBS. FGE for subyearling chinook was estimated at 60%, OPE was in excess of 97%, and descaling was less than 2%. There were problems however, with the durability of the prototype ESBS. Significant damage to the screen occurred after 30 days of operation, requiring the Corps to modify the structural design of the screen. In the Spring of FY99, the modified screens were evaluated in Unit 7 to verify the FY96 results and to specifically document impacts to fry and lamprey. Juvenile salmonids that passed through the test unit gateway incurred high mortality (12-48%). As a result, summer FGE/OPE testing for 1999 was canceled. In 1999 and 2000, the effect of ESBS systems on juvenile lamprey migrants was evaluated. Results from this work clearly showed a benefit for ESBS with narrower clearances over those currently in use on Columbia and Snake River projects. For the remainder of 1999 and through 2001, a new screen system was developed. System components include 1.75mm clearance (fry criteria) ESBS and VBS, and a gateway flow control device. The new system is designed to provide improved gateway hydraulics, and to help protect juvenile lamprey migrants. For FY02, we will test the prototype ESBS, VBS and gateway flow control system developed in 1999 - 2001.

BIOP MEASURE: RPA 73.

OBJECTIVES: (FY02)

1) Evaluate the effectiveness of a prototype intake screen system for both spring and summer juvenile salmonid migrants:

- a. Compare survival and condition between different passage routes: prototype gateway, collection channel and STS gateway.
- b. Determine condition of fish collected from gateway of prototype unit.
- c. Determine FGE.
- d. Determine orifice passage efficiency.
- e. Determine gateway retention time.

SCHEDULE: 1996 - 2004

NOTES:

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: TPE-W-00-1

TITLE: Evaluate Survival and Adult Return Rates of Juvenile Salmon Transported Compared to In-river Migrating Fish

FISH PROGRAM FEATURE: O&M – System - Transportation

BIOP MEASURE: RPA 9.6.1.3.

Significant controversy surrounds the multi-year data sets of juvenile salmonid transport research. Although the majority of tests with spring chinook salmon, steelhead and fall chinook salmon show at least a measurable, if not significantly better return of transported to “control” fish, some entities question the validity of the data set due to concerns such as handling and marking effects on the treatment groups. To re-evaluate the question of transport benefit relative to immigrant survival, efforts have been made to redesign the experiment to answer critical questions relating to transport benefit. This study was designed to compare the benefits of transportation relative to in-river passage using the best operation conditions that were designated for in-river passage conditions each year.

Currently four years of releases have been completed (1995, 1996, 1998 and 1999 releases) from Lower Granite with chinook and (1999) steelhead. Preliminary information from returns indicate that different barging strategies may offer additional increased survival, information from additional years of returns are needed to support future changes to the current operation.

Evaluations on the benefits of transportation from McNary for spring/summer chinook, fall chinook, and steelhead will also be conducted to determine the absolute and comparative return rates of smolts transported to smolts that complete their outmigration.

OBJECTIVES:

1. Determine absolute return rates and comparison ratios of outmigration survival and return rates for transported and in-river migrating spring summer and fall chinook and steelhead smolts. (stock specific)
 - a. Mark juvenile wild spring chinook and steelhead at Lower Granite and fall chinook at hatcheries with PIT tags. (2000-2003) (fall Chinook tagging did not occur in 2000)
 - b. Mark juvenile chinook (fall and spring/summer) and steelhead at McNary with PIT tags (multi-year evaluation). Again, when possible correlate to specific stocks. (2001-2004)
 - c. NEW Evaluation of Transporting Spring/Summer Chinook separate from Steelhead (at LGR)
2. Evaluate fish condition (including stress levels, health, and smoltification) in each marking year throughout the season. (duration of study)
 - a. New: Document changes in nutritional status, including the concentration of macroelements that control osmoregulation during the barging process as they relate to delayed mortality. (Pilot study 2000)

Evaluate and correlate post-release survival and migration behavior of transported and inriver migrants through the estuary and Columbia River plume. Monitor with the PIT tag trawler, radio telemetry and sonic telemetry.

3. Monitor returning adults.
4. Evaluate the effects of handling and marking on survival and adult return rates. Explore the feasibility of pre marking wild fish in the tributaries.
5. NEW Evaluate potential benefits to UCR Chinook, fall chinook and steelhead from transportation at McNary
6. NEW Evaluate the effects on homing of returning adults that have been transported as juveniles

SCHEDULE: 2000-2004 (out-years for adult returns)

NOTES: This study has been identified as a high priority by the Transportation sub-group of the SRWG. Evaluation on the effects of transportation on homing, straying delays and wandering in adults is supported by the Transportation sub-group.

Northwestern Division - Corps of Engineers
ANADROMOUS FISHEVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: TPE-W-00-2

TITLE: Evaluate Post-Release Losses and Barging Strategies that Minimize Post-Release Mortality.

FISH PROGRAM FEATURE: O&M-System-Transportation

BIOP MEASURE: RPA 9.6.3.1

Partitioning mortality throughout the life cycle of salmon and steelhead, and attributing these losses to a specific (dependent) route through the hydrosystem or to random events or an action independent of the hydrosystem is one of the biggest unknowns identified by the analysis of anadromous fish data under the Lower Snake River Feasibility Study. Understanding when, where, and why losses occur may influence the future operation and mitigation actions on the hydrosystem. Information on survival rates of salmon through the hydrosystem is, in general, well known and continues to be evaluated for incremental improvements. However, further downstream and into the oceanic environment delayed mortality or loss is unknown as well as the effects of passage through various routes on these losses. Partitioning losses through these environments will allow for specific transportation strategies to be developed to increase fish survival.

Survival downstream of Bonneville and through the estuary for in-river migrants and transported fish has been studied for spring/summer chinook. Results from these evaluations, although preliminary, suggest that there are several factors contributing to losses in the estuarine environment. These include exposure to avian and piscivorous predators, be it through poor barge release locations, and timing to the tidal cycle, flows or fall migration timing to the estuary. Understanding of the estuarine losses help guide future barging strategies that may increase survival through this area.

Avian predation continues to be a problem in the estuary. About 30% of the juvenile smolts are estimated to be taken by terns colonizing the dredge spoil islands. This predation rate coupled with new information on estuary migration behavior (i.e., passage routes through shallow grass flats, and holding in the fresh water lens, and ocean entry tied to tidal timing) that suggests increased smolt exposure to predation, suggests that mortality through the estuary may be reduced by providing transportation through this environment.

Survival of transported fish from the comparative survival study from Lower Granite show a dramatic increase in the rate of adult returns of fish transported later in the season (~mid May) to those transported earlier. The factors contributing to this difference are unknown but understanding the factors (cyclic patterns of oceanic predators versus estuarine losses) contributing to the early season losses may have potential to reduce post-release losses.

OBJECTIVES:

1. Evaluate post-release survival, behavior, migration characteristics and habitat use of juvenile salmon through the estuary, plume and near shore environment. Methodology: radio telemetry, sonic telemetry – using buoyed receiver arrays and series of bottom receivers. (Fall chinook and steelhead 2000-2003)
 - a. Identify potential trouble areas (delays and losses) and correlate to route of passage, stocks, seasons, and species.
 - b. Determine differences in delayed mortality related to difference in post-release behavior and habitat use in the estuary and plume.
 - c. Determine the relationship of flows to post-release survival downstream of Bonneville.
 - d. Determine seasonal differences in post-release mortality (species and stocks).
2. Evaluate barging strategies to reduce mortality. (Pending the result of the steelhead and fall chinook post-release objectives)
 - a. Determine adult returns of smolts transported and released downstream of Astoria Bridge near the saltwater interface.
 - b. Develop and compare transportation strategies and timing to increase early season survival.
 - c. Evaluate post-release migration behavior, ocean entry timing and timing to the tidal cycle.

SCHEDULE: 2000-2004

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: TPE-W-00-3

TITLE: Evaluate Benefits of Trucking Juvenile Salmonids.

FISH PROGRAM FEATURE: O&M-System-Transportation

BIOP MEASURE: RPA 9.6.1.3

OBJECTIVES:

1. Review and analyze data available from the multiple transportation studies conducted from Lower Granite and compare adult return rates of fish barged versus trucked.
2. Evaluate the comparative survival of fish released from the standard barged-truck sites to other potentially better release locations (Bonneville release pipe).
3. Determine pre-loading truck conditions that may effect fish condition.

SCHEDULE: 2000-2004

NOTES:

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**Northwestern Division – Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: TPE-W-01-1

TITLE: Evaluate the effectiveness of late-season transportation at McNary and Lower Monumental Dams.

FISH PROGRAM FEATURE: Transportation

BIOP MEASURE: RPA 9.6.1.3

Past research on transportation has focused on juvenile salmon that migrate primarily during the spring and summer, and little to no work has been done to evaluate the effectiveness of transporting late migrants. Late migrants are predominantly fall chinook salmon, and a portion of these are ESA-listed Snake River fall chinook. The median date of passage of naturally spawned PIT-tagged Snake River fall chinook salmon past McNary Dam ranges from early to mid August, meaning that half of these fish migrate in late August and into the fall given the protracted smolt outmigration. Beginning in 1992, smolt monitoring and transportation at McNary Dam was extended from October through December. Monthly smolt collections have ranged from a low of 1,838 in October, 1998 to a high of 36,520 in November, 1997. Of interest is whether these late migrating fish produce any adults at all, and whether the cost of late-season transportation is justified given its unknown benefit. The purported benefits of transportation for fall chinook salmon, such as reduced predation and less exposure to high water temperatures, may not be realized during the fall. Conversely, few operational changes are made to improve in-river conditions for migrants in the fall. It is unknown whether transportation is better than in-river migration during the fall.

OBJECTIVES:

- 1) Determine adult contribution from juveniles transported from MCN Dam
- 2) Collect adult return information from marked fish from the Pacific States Marine Fisheries Commission's databases, and determine adult contribution and its relation to time of release.
- 3) Evaluate adult returns relative to transport vs. in-river to assist in determining potential benefit from fall transport at MCN and LMO

SCHEDULE: 2001-2003 (Three years of marking)

NOTES: If fall chinook salmon are marked, then a suitable way of separating shad from chinook must be developed.

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: SPE-W-00-1

TITLE: Total Project Survival of Juvenile Salmon and Steelhead at Lower Snake River and McNary Dams

FISH PROGRAM FEATURE: CRFM - System-Inriver Passage Survival

BIOP MEASURE: RPA 82, 83, 88, 89, and 93.

OBJECTIVES:

1. Statistically determine the route-specific relative survival of juvenile spring and summer chinook or steelhead passing through each route (spill, facility and bypass, and turbine) at Lower Granite, Little Goose, Lower Monumental, Ice Harbor, and McNary Dams under Biological Opinion operations.
2. Evaluate cause-and-effect mechanisms for partitioning survival results including tailrace egress, physical injury due to exposure to structure or hydraulic turbulence, disorientation increasing exposure to predators, etc.
 - a. Evaluate spill survival at Ice Harbor dam. (telemetry and PIT tag study re-scheduled for 2002)
3. Develop operational or structural changes if warranted by the results of objectives 1 or 2.

SCHEDULE: SRWG will determine which projects to test in which years.

NOTES:

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: SPE-W-00-2

TITLE: Project Passage Routing Effectiveness for Lower Snake River and McNary Dams

FISH PROGRAM FEATURE: CRFM - System-Inriver Passage Survival

BIOP MEASURE: RPA 82, 83., 88, 89, and 93

OBJECTIVES:

1. Determine the seasonal and diel variation of turbine, spill, and bypass passage proportions of the BiOp operations. Hydroacoustics and radio telemetry will likely be required.
2. Estimate total project survival by combining survival estimates generated in SPE-W-00-1 with the passage ratios estimated in objective 1.

SCHEDULE: YR2002 at McNary. YR2003 and YR2004 at Lower Granite, Lower Monumental, and McNary. Additional years may be needed to replicate tests for interesting results at either dams where a concern appears, opportunity to optimize operation exists, or implementation of an operation/structural modification requiring validation of effectiveness and survival.

NOTES:

**ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: SPE-W-00-NEW

TITLE: Evaluation of the McNary Dam Spillway Efficiency and Effectiveness.

FISH PROGRAM FEATURE: CRFMP-In-river Passage

BIOP MEASURE: RPA 134 directs the Corps to “continue the spillway deflector optimization program at each Federal Columbia River Power System project and implement it, as warranted.” RPA 134 also directs the Corps to study and evaluate the effects the flow deflectors have on juvenile fish. Flow deflectors currently exist for all spillbays except 1, 2, 21, and 22. Flow deflectors for these four end bays will be installed prior to the 2002 fish passage season. New spill patterns for McNary Dam will be developed using the 1:55 scale general model of McNary Dam. During the 2002 fish passage season the spill efficiency and effectiveness will be studied with the new flow deflectors and spill patterns. RPA 135, 82, and 83 also addressed.

OBJECTIVES: (FY02)

1. Estimate the spill efficiency and effectiveness under the new spill patterns.
2. Monitor tailrace egress in the stilling basin and at the bypass system outfall under the three test discharges, and determine differences that may lead to increases in predation.

SCHEDULE: 2002 - 2003

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE-W-00-6

TITLE: Ecological Effects of Water Temperatures and Maximized Spill on Prey of Juvenile Salmonids

FISH PROGRAM FEATURE: System – Normative River

BIOP MEASURE:). Return to the River (ISG 1996) “normative” river concept addressing effects of pre- vs. post-drawdown ecological function. ISAB Review on Corps DGAS Program (1998). Transboundary Gas Group’s Biological Effects and Research Information Paper and Research Plan (1999). RPA 83, 115, and 141.

Background: Investigative monitoring performed by University of Idaho in 1996 and 1997 showed that entrapped gas bubbles and high scouring water velocities resulted in overbouyancy and increased drift of the limited macroinvertebrate population abundance and diversity downriver of Lower Granite, Little Goose, and Lower Monumental dams (Bennett and Nightengale 1996, 1997).

OBJECTIVES:

1. Quantify hydraulic induced drift displacement, scouring, and investigate recolonization potentials for macroinvertebrate guilds that are utilized by migrating, rearing, or overwintering smolts in the lower Snake River.
2. Quantify effects on resident fish larvae and fry and their displacement in relation to spill kcfs treatments. (*Ho: Spill has benefits due to reducing age class strength and compensation to predator species, thus reducing reach-specific predation. H1: Spill has little or no effect on predator species composition or age class strength, thus only acts to modify exposure time of smolts to predators*).
3. Quantify effects of water temperature, spill quantity, and %TDGS on subyearlings that rear and/or overwinter in McNary reservoir or a lower Snake River reservoir and pass the lower Columbia River as yearlings the following spring versus their true “subyearling” cohorts that outmigrated their first summer.
(*H0: The subpopulation of Snake River fall chinook from the Snake River (with the historically high temperatures) that overwinters above McNary Dam to outmigrate early next spring has a three fold increase in their adult return rates as compared the “true subyearling” cohort is an evolutionarily adapted lifehistory. H1: The subpopulation overwinters in response to passage conditions; water temperature, spill quantity, flow/travel time*).

SCHEDULE: 2002 – 2005 (Placeholder for Normative River)

Northwestern Division- Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE-P-00-7 (formerly MPE-98-4)

TITLE: Evaluation of the John Day Dam Spillway as a Juvenile Salmon Passage Route.

FISH PROGRAM FEATURE: CRFMP-In-river Passage

BIOP MEASURE: Spill patterns at the John Day Dam were developed during the 1980s to facilitate fish passage from the forebay. Although tailrace conditions were considered, they were not the primary focus. Therefore in 1995, the Corps constructed a 1:80 scale general model of the John Day Dam project and began a hydraulic evaluation of the spillway operation given the existing spill patterns. This evaluation was required by the NMFS Biological Opinion for Operation of the Federal Columbia River power System (BiOp), Incidental Take Statement (ITS) number 2. Initial investigations on the model confirmed that tailrace conditions given the existing spill patterns were not desirable. Under most conditions, large eddies formed in the tailrace, and dye was retained for extended periods of time. A new pattern was developed for the 1996 and 1997 fish passage seasons, primarily to control dissolved gasses. With the completion of flow deflectors on the John Day spillway, the patterns were redeveloped to reduce tailrace eddies, limit impacts to the juvenile bypass system outfall, limit retention time in the stilling basin and help to control dissolved gas. In FY98 the new patterns were evaluated under BiOp required flows for both the spring and summer outmigrations using hydroacoustics and radio telemetry. Spill effectiveness was high, forebay retention low, and tailrace egress relatively quick and direct. In 1999 and 2000 the effect of 24 hour spill on FPE, SPE, and forebay retention time was evaluated. For both years, spring migrant FPE was not significantly different between 12 hour versus 24-hour spill, however FPE did differ significantly for summer migrants in 2000. Forebay retention time was shorter for both spring and summer migrants under the 24-hour spill condition. In 2000, survival was estimated at John Day using radio telemetry. Reporting for this study is not yet complete, but preliminary spring migrant results indicate a substantially lower spillway survival rate for 24-hour spill compared to 12-hour night spill only. Tailrace egress information collected in 2000 showed that fish entering the tailrace via the juvenile fish bypass outfall had slower egress from the tailrace than fish passing the spillway. In addition, bypassed fish had significantly longer tailrace residence times under the 60% nighttime spill condition compared the 30% day spill condition. Future spill evaluations at John Day should focus on causes for lower spillway survival rates under the 24-hour spill condition, the benefits of reduced forebay residence time, and tailrace egress and survival for fish that pass via the juvenile bypass system.

OBJECTIVES: (FY02).

1. Assess survival rates for 12 and 24-hour spill operations.
 - estimate project survival rates for the two spill conditions.
 - estimate survival rates of spring and summer migrants that pass via spill.
 - estimate survival rates for fish that pass via the juvenile bypass system.
2. Monitor tailrace egress in the stilling basin and at the bypass system outfall under the three test discharges, and determine differences that may lead to increases in predation.

SCHEDULE: 1998 - 2003

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: SPE-P-00-8

TITLE: Juvenile Salmonid Survival Studies at The Dalles Dam

FISH PROGRAM FEATURE: CRFMP- In-river Passage

BIOP MEASURE: RPA 68, 69, and 70. The Dalles Dam stilling basin is relatively shallow, and a large volume of water can be spilled without increasing total dissolved gas (TDG) levels above 120%. As a result, the spillway has been a primary passage route at The Dalles Dam, and spill has accounted for 64% of total river discharge at from 1995 through 1997. In 1995, Normandeau Associates evaluated survival at The Dalles spillway using balloon-tagged fish that were released under a 3-bay operation. Only 94% of the balloon tagged fish were recovered and survival through an existing bay was estimated at 95.5%. From 1997-2000, the National Marine Fisheries Service (NMFS) evaluated survival at The Dalles Dam using passive integrated transponder (PIT) tagged smolts. Their objective was to assess whether spillway passage survival under 64% spill was high (98%) and if not, determine whether lower spill rates would improve survival. Based on 1997-2000 survival results, NMFS found that percent spill affected survival, with 30% spill resulting in higher survival than 64%. The 40% spill level used with the juvenile pattern in 2000 resulted in survival rates similar to those seen under the 30% spill levels tested previous years. NMFS found that survival for subyearling chinook was consistently higher at night than in the day. This trend is not consistently seen with spring migrants. NMFS also estimated turbine passage survival at The Dalles Dam in 2000. The estimates produced were surprisingly low, with spring migrant survival at 81% and summer migrants at 84%. In addition to survival, the Corps evaluated fish passage efficiency (FPE), spill passage efficiency (SPE), sluice passage efficiency, and tailrace egress behavior, using radio telemetry and hydroacoustics. FPE and SPE were similar between the 40% juvenile spill condition used in 2000 and the 64% spill condition tested in 1999. Under 40% juvenile spill, fewer fish passed via the ice and trash sluiceway however. Based on FPE research, we know the spillway can pass a large proportion of the juvenile migrant run. However spillway survival, while improved at 30-40% compared to 64%, is still unacceptably low for a primary passage route. In addition, turbine survival is lower than we would expect, based on survival seen at other dams. In order to realize passage improvements at The Dalles Dam, it is necessary to understand whether survival can be increased through spillway, turbine, and sluiceway modifications. Therefore, the scope of survival studies has shifted from obtaining point survival estimates under various operating conditions, to identifying mortality mechanisms. This information will help guide spillway, turbine, and sluiceway improvements currently under development in separate programs.

OBJECTIVES: (FY02)

1. Characterize the Stilling Basin Environment
 - Describe the environment fish experience during passage in spill.
 - Visualize and further analyze fish exposure conditions.
2. Estimate Direct Mortality and Injury Rates
 - Estimate mortality and injury rates of balloon-tagged yearling and subyearling chinook that pass the spillway (2002).
 - Estimate mortality and injury rates of balloon-tagged juvenile salmonids that pass through a tuned and painted turbine unit versus an untuned, unpainted turbine unit (*placeholder 2002*).
 - Estimate mortality and injury rates of balloon-tagged yearling and subyearling chinook that pass through the ice and trash sluiceway (*placeholder 2002*).
3. Estimate Juvenile Salmonid Travel Paths through the Stilling Basin
 - Determine passage routes through the stilling basin for fish passing one north and one south spillbay.
 - Determine stilling basin retention time for fish passing one north and one south spillbay.
4. Estimate Indirect Spillway Mortality Rates.
 - TBD (*placeholder for 2002*)
5. Continue to develop and refine spatially explicit models that output the probability of habitat use by northern pikeminnow, smallmouth bass, and juvenile salmonids in The Dalles Dam tailrace under different operational scenarios.

SCHEDULE: 1997 – 2005

**North Pacific Division -- Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: SPE-P-02-9

TITLE: Survival of Juvenile Salmonids at Bonneville Dam.

FISH PROGRAM FEATURE: CRFMP - Bonneville

BIOP MEASURE: Per the National Marine Fisheries Service, Biological Opinion (RPA 82) the Portland District has been evaluating survival through all juvenile salmonid fish passage routes. RPA 134 directs the Corps to evaluate spillway deflector optimization at each FCRPS project. Project survival, and route specific survival data are necessary to further assess future fish passage programs at the Bonneville project.

OBJECTIVES:

1. Obtain project survival for the entire Bonneville project.
2. Obtain route specific survival for the Bonneville spillway. This will include direct and indirect survival estimates for new and old flow deflector bays. Further, the analysis will attempt to evaluate survival with different tailwater elevations.
3. Obtain route specific survival in the spring for juveniles passing through the B1 Juvenile Bypass System.
4. Obtain route specific survival estimates (both direct and indirect) for juvenile salmonids passing through one of the new B1 minimum gap runner turbines (probably main unit 6).
5. Obtain route specific survival estimates (both direct and indirect) for juvenile salmonids passing through the new B2 juvenile bypass system outfall.

SCHEDULE: 2002-2003 (the need for additional information will be evaluated at the end of study)

NOTE:

**North Pacific Division - Corps of Engineers
Anadromous Fish Evaluation Program
RESEARCH SUMMARY**

Study Code : SPE-P-02-10 (formerly SBE-P-00-7) *Placeholder*

TITLE: Evaluations and Studies of Fish Passage Efficiency at Bonneville Dam.

FISH PROGRAM FEATURE: CRFMP - Bonneville – Surface Flow Bypass (SFB).

BIOP MEASURE: Reasonable and Prudent Alternative (RPA) 83 directs the Corps to evaluate spill efficiency and effectiveness at all FCRPS projects. Fish passage efficiency evaluations will also provide critical information for survival studies described in SPE-02-9. In addition, RPA #61 directs the COE to complete evaluations of the Powerhouse One prototype surface collector. This study will provide information on fish behavior and distribution necessary for the design of surface collection technologies.

OBJECTIVES:

1. Estimate the proportion of juvenile salmon passing the project through each powerhouse and the spillway.
2. Estimate the fish passage efficiency of both powerhouses.
3. Develop a mathematical model of the spill efficiency - spill level response curve.
4. Determine mean densities of juvenile salmon for each depth bin, horizontal bin, and transect; by day/night, season.

SCHEDULE: 2002 – 2003

NOTE:

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: SBE-W-96-1

TITLE: Migrational Characteristics of Juvenile Spring and Fall Chinook Salmon and Steelhead in the Forebay of Lower Granite Dam Relative to the Removable Spillway Weir.

FISH PROGRAM FEATURE: CRFMP – Lower Granite, Surface Bypass Program

PROBLEM STATEMENT: The Corps of Engineers plans to design and construct a removable spillway weir (RSW) and install it at spillbay 1 of Lower Granite Dam. The RSW will likely be operated in conjunction with the Behavioral Guidance Structure (BGS). The existing Surface Bypass/Collector (SBC) and Simulated Wells Intake (SWI) will be in place and act as an occlusion device for fish approaching the powerhouse. It is anticipated that the BGS, SBC and SWI will direct a large proportion of the fish approaching the dam into the vicinity of the RSW. The operations of the dam have not been agreed to at this time. There will likely be some combination of spill, RSW flow and powerhouse in perhaps more than one combination during the out-migration. Monitoring efforts need to center on how fish approach the dam and what their final route of passage is.

BIOP MEASURES: Action 80. “The Corps shall continue the design development, fabrication/deployment and testing of a prototype RSW at Lower Granite, in conjunction with the existing prototype powerhouse occlusion devices, including the forebay BGS and upper turbine intake occlusion devices.”

OBJECTIVES:

1. Determine, through radio-telemetry, the relative passage rates of juvenile salmonids through the powerhouse, bypass system, spillway and RSW.
2. Determine, through radio-telemetry, the effectiveness and efficiency of the various passage routes of powerhouse, bypass system, spillway and RSW.
3. Track fish in the vicinity of the BGS, SBC/SWI and RSW to determine behavioral characteristics associated with the 2002 configurations and flows.

SCHEDULE: 2002 - ??

NOTES: All routes of passage need to be covered for a complete evaluation of fish passage at Lower Granite. If the interest is more limited, then all routes may not need to be evaluated.

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SBE-W-96-2

TITLE: Fixed-Location Hydroacoustic Evaluation of the Removable Spillway Weir at Lower Granite Dam.

FISH PROGRAM FEATURE: CRFMP – Lower Granite, Surface Bypass Program

PROBLEM STATEMENT: The Corps of Engineers plans to design and construct a removable spillway weir (RSW) and install it at spillbay 1 of Lower Granite Dam. The RSW will likely be operated in conjunction with the Behavioral Guidance Structure (BGS). The existing Surface Bypass/Collector (SBC) and Simulated Wells Intake (SWI) will be in place and act as an occlusion device for fish approaching the powerhouse. It is anticipated that the BGS, SBC and SWI will direct a large proportion of the fish approaching the dam into the vicinity of the RSW. The operations of the dam have not been agreed to at this time. There will likely be some combination of spill, RSW flow and powerhouse in perhaps more than one combination during the out-migration. Monitoring efforts need to center on how fish approach the dam and what their final route of passage is.

BIOP MEASURES: Action 80. “The Corps shall continue the design development, fabrication/deployment and testing of a prototype RSW at Lower Granite, in conjunction with the existing prototype powerhouse occlusion devices, including the forebay BGS and upper turbine intake occlusion devices.”

OBJECTIVES:

1. Determine, through fixed hydroacoustics, the relative passage rates of juvenile salmonids through the powerhouse, bypass system, spillway and RSW.
2. Determine, through fixed hydroacoustics, the effectiveness and efficiency of the various passage routes of powerhouse, bypass system, spillway and RSW.
3. Determine behavior of fish in the direct vicinity of the RSW.

SCHEDULE: 2002 - ??

NOTES:

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: SBE-W-99-3

TITLE: Condition and/or survival of juvenile chinook salmon and steelhead passing through the Removable Spillway Weir (RSW) at Lower Granite Dam

FISH PROGRAM FEATURE: CRFMP – Lower Granite, Surface Bypass Program

PROBLEM STATEMENT: The RSW scheduled for installation at spillbay 1 of Lower Granite Dam is a different method of passing fish through a spillway. Although it intuitively looks better for fish passage than going under a tainter gate, there may be problems that are not apparent.

BIOP MEASURES: Action 80. “The Corps shall continue the design development, fabrication/deployment and testing of a prototype RSW at Lower Granite, in conjunction with the existing prototype powerhouse occlusion devices, including the forebay BGS and upper turbine intake occlusion devices.”

OBJECTIVES:

1. Determine, through the use of balloon tags or other methods, the short-term survival and injury rate of fish passing over the RSW and under a tainter gate at a nearby spillbay.

SCHEDULE: Fall 2001 or spring 2002.

NOTES:

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SBE-W-00-4

TITLE: Use of turbulent attraction flows or other guidance cues to guide fish at a diversion structure or to the Removable Spillway Weir (RSW) at Lower Granite Dam.

FISH PROGRAM FEATURE: CRFMP – Lower Granite, Surface Bypass Program

PROBLEM STATEMENT: There have been instances of entrance efficiencies at the Lower Granite Surface Bypass/Collector (SBC) that have been lower than hoped for. One of the ideas for guiding fish into a surface oriented entrance has been the use of mild turbulence for fish to follow. Preliminary tests of this concept at Cowlitz Falls Dam in 1999 and 2000 have proven promising.

BIOP MEASURES: Action 86. The Corps shall continue to investigate a way to increase entry rates of fish approaching surface bypass/collector entrances.

OBJECTIVES:

1. Determine if turbulent flow or other guidance cues can be used to direct fish in the Lower Granite forebay or other locations.
2. Determine if turbulent flow or other guidance cues can be used to increase the entrance efficiency of the RSW at Lower Granite or other locations.
- 3.

SCHEDULE: 2002 - ??

NOTES: This concept could also be used at the upstream end of the BGS at Lower Granite to keep fish from passing through the upstream gap, thereby eliminating the need to close this gap for juvenile fish guidance.

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SBE-W-00-5

TITLE: Three-Dimensional Fish Tracking in the Vicinity of the Lower Granite Removable Spillway Weir (RSW).

FISH PROGRAM FEATURE: CRFMP – Lower Granite, Surface Bypass Program

PROBLEM STATEMENT: A better understanding of fish behavior in the Lower Granite forebay, especially in the vicinity of the RSW, is needed in order to discover if the RSW is an attractive passage route for juvenile fish. This information could be combined with field measurements of flow and other variables, or could be combined with numerical model information on flow.

BIOP MEASURES: Action 80. “The Corps shall continue the design development, fabrication/deployment and testing of a prototype RSW at Lower Granite, in conjunction with the existing prototype powerhouse occlusion devices, including the forebay BGS and upper turbine intake occlusion devices.”

Action 85. “The Corps shall continue to develop and evaluate improved fish-tracking technologies and computational fluid dynamics (numerical modeling)”

Action 86. “The Corps shall continue to investigate a way to increase entry rates of fish approaching surface bypass/collector entrances.”

OBJECTIVES:

1. Collect three-dimensional information on fish movements in the Lower Granite forebay, especially in the vicinity of the RSW.

SCHEDULE: 2002 - ??

NOTES: Similar work was conducted at Lower Granite in 2000 in conjunction with the operation of the BGS and SBC.

**North Pacific Division - Corps of Engineers
Anadromous Fish Evaluation Program
RESEARCH SUMMARY**

Study Code : SBE-P-95-9 (formerly SBE-P-95-2) Placeholder

TITLE: Development of Fish Sampling Capability for evaluation of Surface Flow Bypass (SFB).

FISH PROGRAM FEATURE: CRFMP - Bonneville, The Dalles, and John Day – Surface Flow Bypass.

BIOP MEASURE: Reasonable and Prudent Alternative #11 directed the COE to investigate the application of surface collection technology at lower Snake and Columbia River projects. Reasonable and Prudent Alternative 2 requires spill to achieve 80 percent fish passage efficiency. Sluiceways can be significant components of project passage. Hydroacoustics has been the primary evaluation technique for surface collector's entrances. It has not been possible to determine definitively whether fish have entered or were merely present at the entrance. Wind entrained air often cause excessive noise in the surface. Therefore, alternative methods to estimate the number of juvenile salmonids entering the collector need to be developed. Statistical evaluations have shown that 90% detection probability would provide meaningful passage estimates. A 48" detector was to be designed for laboratory testing in 1998.

OBJECTIVES:

1. Evaluate a large prototype diameter, low frequency, and submersible PIT detector for use in The Dalles sluiceway, the Bonneville 2 sluiceway, and similar environments (surface collectors).
 - a. Construct a multiple detector array and deploy in selected test environment. Confirm the hydrodynamic performance of the multiple detector arrays.
 - b. Calibrate the detection performance of the multiple detector array using PIT tagged fish released upstream of the array location.
 - c. Integrate array into evaluation of surface bypass prototypes during 2000 outmigration.

SCHEDULE: 2002 - 2004

NOTE:

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: SBE-P-00-17 (formerly MPE-P-96-1)

TITLE: Studies of Surface Flow Bypass at The Dalles Dam.

FISH PROGRAM FEATURE: CRFMP - The Dalles - Surface Flow Bypass.

BIOP MEASURE: Reasonable and Prudent Alternative #11 directed the COE to investigate the application of surface collection technology at lower Snake and Columbia River projects and Incidental Take Statement 10 directed the COE to investigate the passage behavior of juvenile salmon migrants, both in timing and passage efficiency.

Studies since 1995 have supported earlier research that indicated 20% to 40% of the juvenile migrants pass the project through the sluiceway. For the volume of flow it is perhaps the most efficient passage route in the Columbia River Basin. In 1997 turbine entrainment was estimated at 5% - 10% depending on level of spill (30% or 64%). However, studies in 1995 and 1996 suggested that occluding the upper portion of turbine intakes could further reduce turbine entrainment. Further, investigation on Surface Flow Bypass for Lower Granite Dam revealed that the box-shaped collector modified flow lines into the intake to a greater extent than the simple occlusion plates installed at The Dalles in 1996. Currently model testing is underway to develop a more effective intake occlusion device. In FY01 a redesigned occlusion device will be available to field-testing. Note that Fish Passage Efficiency Studies are proposed under the survival program. Therefore, the additional research costs for this field evaluation will be minimal.

Because of the efficiency of the existing sluiceway discussed above it is prudent to conduct thorough studies of fish behavior at the sluiceway. Detailed hydraulic and fish behavior studies could reveal clues to fish behavior that may lead to improved success at other sites in addition to information directly applicable to The Dalles. Such studies will require precise 3-dimensional location estimates of individual fish over several meters. Additionally, the hydraulic conditions, including 3-dimensional vectors and acceleration must be estimated for each fish location. Thorough analysis of these combined hydraulic and fish movement data sets will be necessary to meet the objective of these studies. Other stimuli, such as sound could be also be evaluated.

OBJECTIVES:

1. Determine differences in spillway and sluiceway fish passage efficiency with and without intake occlusions.
2. Estimate the entrance efficiency of the sluiceway with and without intake occlusions.
3. Determine the correlations between specific fish movements, specific hydraulic conditions of velocity and accelerations, depths, and other physical factors.
4. Describe patterns in the history of hydraulic conditions encountered by fish that entered the sluiceway and those that did not.
5. Determine project wide Fish Passage Efficiency (FPE).

SCHEDULE: 2001 - 2003

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: SBE-P-0-1

TITLE: Studies of Surface Flow Bypass at John Day Dam.

FISH PROGRAM FEATURE: CRFMP – John Day - Surface Flow Bypass/Surface Spill.

BIOP MEASURE: Reasonable and Prudent Alternative #11 directed the COE to investigate the application of surface collection technology at lower Snake and Columbia River projects and Incidental Take Statement 10 directed the COE to investigate the passage behavior of juvenile salmon migrants, both in timing and passage efficiency.

Surface Flow Bypass (SFB) has been evaluated for the past several as a means to enhance juvenile salmonid passage and survival past Corps operated hydroelectric facilities. Most SFB programs have focused on powerhouse passage. The primary focus at John Day has been the possible use of one or more of the four skeleton bays as use as a high volume SFB. At the completion of the design memorandum for the skeleton bay SFB, regional fishery managers deemed the cost too high given the uncertainties. The region directed the Corps to evaluate a possible less expensive alternative to evaluate the SFB concept. The Portland district in coordination with regional fishery managers designed a Removable Spillway Weir (RSW) for an evaluation in 2002. However, given additional uncertainties with fish condition and survival with a high discharge and extended flow deflector, and the potential for high levels of total dissolved gas production, the Corps has recommended testing the high flow and extended deflector prior of construction of the RSW. If fish condition and survival are acceptable, and dissolved gas levels are acceptable the Corps will construct the RSW for efficiency evaluations beginning in 2003.

OBJECTIVES:

1. Determine fish condition and survival passing through spillbay 20 with approximately 16 Kcfs and an extended flow deflector.
2. Determine water quality and total dissolved gas production through spillbay 20 with approximately 16 Kcfs and an extended flow deflector.

SCHEDULE: 2002 - 2004

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: OTS-W-00-1

TITLE: Study of Causal Mechanisms of Fish Injury Within the Turbine Environment at McNary Dam.

FISH PROGRAM FEATURE: CRFMS – System Studies – Turbine Passage Survival

PROBLEM STATEMENT: Fish injury/mortality estimates for turbine have been made in the past using balloon tags and PIT tags. These estimates were for the general turbine environment and the release mechanisms were such that the fish route through the turbine was unknown. Model studies have identified areas within the turbine that have a high probability of injuring or killing fish during passage. Tests done in spring 1999 indicated small differences in mortality and injury between passage routes at McNary unit 9, but tests were only done at one power level with hub and tip gaps and wicket gate angles all at a “moderate” setting. Further testing is needed to determine fish injury and mortality throughout a range of turbine operations.

BIOP MEASURES: Reasonable and Prudent Alternative (RPA) Action 88 – “The Corps and BPA...shall continue the program to improve turbine survival of juvenile and adult salmonids.” RPA action 89 – “The Actions Agencies shall investigate hydraulic and behavioral aspects of turbine passage by juvenile steelhead and salmon through turbines to develop biologically based turbine design and operating criteria.”

OBJECTIVES: Determine causal mechanisms/areas of injury to juvenile salmonids with the turbine environment through multiple releases of fish into the turbine intake. This will be done by releasing fish through pipes into the turbine so that they pass in specific locations. These locations were identified in a physical model as locations where fish have either a high or low probability of injury or mortality. An initial study of this type was conducted in 1999.

Specific objectives for 2001

- a. Compare fish injury and mortality through up to four previously established release points at two or more different turbine settings with maximum and minimum blade and wicket gate angles.
- b. Quantify tail-log slot entrapment of juvenile fish.
- c. Add control release to obtain absolute point estimates of passage mortality at the different locations and different power settings.

SCHEDULE: Phase I Field Work 1999 – 2002

NOTES: 1999 test took place in late May, early June during high spill period. 2002 test will likely be much earlier in the year, possibly late February or March when conditions are more favorable for prompt fish retrieval. Possible work for outyears: further partitioning of turbine/draft tube impacts on fish.

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: OTS-W-01-1

TITLE: Impacts to adult fish while passing through turbines.

FISH PROGRAM FEATURE: CRFMS – System Studies – Turbine Passage Survival

PROBLEM STATEMENT: Little is known about injury and mortality to adult-sized salmonids passing through kaplan turbines. There is increasing interest about adult passage downstream, both from the standpoint of migrating steelhead kelts and for the adult salmon fallbacks.

BIOP MEASURES: Action 88. “The Corp and BPA, in coordination with the Fish Facility Design Review Work Group and the Fish Passage Improvement Through Turbines Technical Work Group, shall continue the program to improve turbine survival of juvenile and adult salmonids.”

Action 93. “The Action Agencies shall determine the number of adults passed through turbines. Then, if warranted, investigate the survival of adult salmonid passage through turbines (including steelhead kelts.)”

a. OBJECTIVES:

The adult passage survival pilot study will be the first known study to evaluate the passage of adults fish through Kaplan turbines. This study will be designed to evaluate test methods as well as turbine survival of adult fish.

1. Evaluate methods available to study injury to adult sized fish during turbine passage.

a. Obtain estimates of recapture probability for “healthy” and “stunned” adult sized fish using balloon tag methods.

b. Evaluate the use of combined depth sensing acoustic transmitters and gastric implant radio transmitters for indirect observation of the health status of “healthy” adult migrant test fish prior to recovery using balloon tags. (Determine if the movement patterns of test fish in the tailrace can be used to evaluate the health status after turbine passage.)

1. Obtain data sets of sufficient quality to estimate sample size requirements for more definitive estimates of adult fish injury and mortality rates as a function of turbine operation geometry.

2. Obtain initial rough estimates of the effects of turbine passage on kelts, jacks, other adult salmonids and large resident fish.

3. Obtain detailed observations of the behavior of adults sized fish following exit from draft tubes.

4. Obtain large sensor fish data (including strike observations) for the exposure conditions for adult sized migrants during turbine passage.

SCHEDULE: Sensor fish development – 2001 Construct prototype – winter 2000-01. Test prototype at McNary turbine – spring 2001.

NOTES:

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: OTS-W-02-1 (NEW)

TITLE: Estimation of “total turbine” mortality (direct and indirect) for juvenile salmon and steelhead.

FISH PROGRAM FEATURE: CRFMP – System Studies – Turbine Passage Survival

PROBLEM STATEMENT: The impact of draft tube passage and tailrace conditions on ultimate survival is unknown at this time. The juvenile fish mortality associated with the tailrace environment may be as significant or more significant than direct mortality caused by fish passing through the turbine. Fish injured or disoriented by turbine passage may be preyed on disproportionately by piscivorous fish and birds in the tailrace area. Passage through the draft tube may also inflict injury or mortality or may disorient fish so they are not immediately able to escape from predators. Most studies to date have concentrated on direct turbine mortality.

BIOP MEASURES: RPA action 90 – “The Action Agencies shall examine the effects of draft tubes and powerhouse tailraces on the survival of fish passing through turbines.”

OBJECTIVES: The overall objective of this study is to partition out where, in the turbine environment and tailrace, mortality is occurring and what the cause of that mortality is.

Specific objectives:

1. Estimate total turbine (turbine passage plus draft tube/tailrace) mortality rates for one or more turbine operation/tailrace conditions.
2. Estimate tailrace mortality rates of fish that have not passed through the turbine/draft tube for one or more turbine operation/tailrace conditions. (What portion of mortality is due solely to the tailrace environment.)
3. Estimate tailrace mortality rates for fish that have passed through the turbines (and were not direct mortalities.)
4. Estimate what portion of the total mortality rate is caused by direct turbine passage, indirect turbine passage (mortality in tailrace due to turbine passage) and factors outside of the turbine environment (tailrace mortality of fish unaffected by turbine passage).

SCHEDULE: 2002 - ??

NOTES:

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: ADS-00-1

TITLE: Evaluation of Adult Salmon and Steelhead Fallback at Snake and Columbia River Dams

FISH PROGRAM FEATURE: System - Adult Passage

PROBLEM STATEMENT: Salmon and steelhead fallback at Columbia and Snake river dams has been well documented. Rates of fish falling back over dams can reach 20% during periods of high spill. Recent radio telemetry information collected by USGS/NMFS indicates that survival for fish that fall back at a dam is approximately 5% less than for fish that do not fall back. In addition, escapement to tributaries decreases with increasing fallback events. To understand the causes of fallback and develop solutions, more information is required. Specifically, what fish are most susceptible to fallback, where is fallback occurring, what are the causes of fallback, and what is the effect of fallback on adult survival to spawning.

BIOP MEASURES: This evaluation is included under Reasonable and Prudent Alternatives (RPA) 60, 93, 111, 112, and 113 in NMFS 2000 Biological Opinion for Operation of the Federal Columbia River Power System.

OBJECTIVES:

1. Evaluate the effect of new spill operations on the fallback routes, percentages and rates.
 - a. Bonneville Dam flow deflectors – 2002-03.
 - b. McNary end bay deflectors – 2002-03.
 - c. Lower Granite RSW – 2002-03.
 - d. John Day RSW - 2002-03.
 - e. Little Goose end bay deflectors 2006—2007
 - f. Lower Monumental end bay and spillway repair 2005-2006
2. Evaluate forebay migration routes and fallback rates for fish released at Bradford Island alternative exit sites - 2000-2003.
3. Evaluate turbine fallback: estimate rates, and survival of fish falling back through turbines at all COE projects on the Columbia and Snake River – 2001-2004.
4. Evaluate fallback into juvenile bypass systems.
 - a. Determine number, seasonal timing, passage time, and condition of adult salmon and steelhead that fallback through juvenile fish facilities – placeholder pending results of 2000 evaluation.
 - b. Evaluate structural and operational changes designed to reduce entrainment of adults into the juvenile fish facility, to reduce holding in the collection channels, and to provide an exit from the collection channel. (2002 – 2003)
5. Compare the probability to reach stream or hatchery of origin between known-source (PIT tagged) fish that fallback and known source fish that do not fallback.
6. Identify tag retention rates for fish that fall back at dams.

SCHEDULE: 1995 - 2007

NOTES:

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-00-2

TITLE: Evaluation of Adult Salmon and Steelhead Delay at Snake and Columbia River Dams

FISH PROGRAM FEATURE: System - Adult Passage

PROBLEM STATEMENT: Past and recent radio telemetry studies demonstrate that adult migrants are delayed at dams. Project passage times can range from 1 to 1174 hours. Compilation of past telemetry data show median project passage times ranging from 30 to 60 hours for Bonneville, The Dalles, and John Day dams. The most recent radio telemetry data show dam passage times to be less than 24 hours, passage through reservoirs to be less than through free-flowing rivers, and passage through the system to be equal to or less than through the free-flowing Snake River. How migration delay affects adult salmon and steelhead spawning success is not well understood. Past and recent studies point to the time to first entrance and transition pools as the primary areas of delay at projects.

Fish Passage Plan entrance criteria cannot be satisfied at some ladder entrances when tailwater elevations are low. It is not clear if passage is delayed or hindered by not meeting the criteria. An experimental evaluation of these criteria would be valuable in considering modified operations, or potential extensive modifications to these systems.

BIOP MEASURES: This evaluation is included under Reasonable and Prudent Alternatives (RPA) 116, 117, 119, and 120 in the NMFS 2000 Biological Opinion for Operation of the Federal Columbia River Power System.

OBJECTIVES:

1. Assess the effect of collection channel modifications on migration delay (sixth year of ongoing study).
 - a. Test for differences in passage times between junction pool/ladder transitions modified with weirs that have enhanced orifice attraction flow and junction pool/ladder transitions with existing weirs (limited attraction flow) – placeholder pending 2001 results.
 - b. Evaluate the passage times and routes at Columbia and Snake river dams with closed floating orifice gates – placeholder, depending on results of FY01 testing.
2. Evaluate passage times through count stations.
 - a. Analyze existing data from Bonneville Washington shore ladder count station, and other previously monitored count stations to define problem - 2002
 - b. Conduct additional evaluations if warranted, based on existing data – 2003 - ?
3. Determine the biological effects of operating entrances outside FPP criteria.

SCHEDULE: 1995 - 2004

NOTES:

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: ADS-00-3

TITLE: Investigation of Unaccounted Losses in Adult Chinook and Steelhead Migrants.

FISH PROGRAM FEATURE: System - Adult Passage

PROBLEM STATEMENT: Adult salmon and steelhead migrating through the Federal Columbia River Power System suffer mortality due to harvest, injury or disease. Radio telemetry has helped us partition specific factors contributing to these losses, however substantial numbers of fish tagged with transmitters remain unaccounted for. In 1996, for example, nearly 20% of all adult chinook salmon tagged with transmitters were unaccounted for. The greatest number and proportion of unaccounted for losses occurred between Bonneville and The Dalles dams in 1996 (67 unaccounted losses out of a total of 335 fish in section). Detailed information regarding where and how these losses occur is essential in order to minimize mortality of adult salmon and steelhead as they migrate through the power system.

BIOP MEASURES: This evaluation is included under Reasonable and Prudent Alternatives (RPA) 107,108, and 118 in the NMFS 2000 Biological Opinion for Operation of the Federal Columbia River Power System.

OBJECTIVES:

1. Determine fate of transmitter-tagged chinook and steelhead as they migrate through Bonneville, The Dalles and John Day pools on the Columbia River.
 - a. Partition loss by cause (i.e. spit tags, harvest, turnout into unmonitored area, mainstem spawning, etc) and location.
 - b. Define factors that may lead to losses (i.e. fallback, wandering).
2. Estimate survival of known-source adult chinook and steelhead between Bonneville Dam and stream of origin.

SCHEDULE: 1995 - 2002

NOTES:

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: ADS-00-4

TITLE: Investigation of Straying and Wandering in Adult Salmon and Steelhead.

FISH PROGRAM FEATURE: System - Adult Passage

PROBLEM STATEMENT: Large numbers of steelhead and some chinook salmon destined for the Snake River, enter lower Columbia River tributaries. From radio telemetry data, we can tell which fish enter tributaries and later move into the Snake River but cannot estimate the number of Snake River fish that enter lower river tributaries and die before returning to the Snake River. The proportion of fish that stray and spawn in non natal streams is unknown. Straying is a natural characteristic of salmon populations that serves to colonize vacant habitat, and to increase genetic diversity. However, excessive straying can genetically swamp the locally adapted population. The hypothesis has been raised that the COE program of transporting juvenile salmonids downstream many cause increased straying.

In 2000, there did not seem to be a problem with fish straying more after being barged than those that stayed in river. Salmon PIT tagged as juveniles above Lower Granite and detected at Bonneville in 2000 as adults reached Lower Granite in similar proportions whether or not they were transported. Seventy-three percent (91 of 124) of the adults that were transported as juveniles reached Lower Granite and 76% (54 of 71) that migrated in-river as juveniles reached Lower Granite.

By using radio telemetry to track the migration of known source fish (PIT tagged fish) we can better define the extent and potential causes of straying.

BIOP MEASURES: This evaluation is included under Reasonable and Prudent Alternative (RPA) 48 in the NMFS 2000 Biological Opinion for Operation of the Federal Columbia River Power System.

OBJECTIVES:

1. Compare wandering and straying rates between radio transmitter tagged adults known to have been transported as smolts, and radio transmitter tagged adults known to have migrated in-river as smolts - placeholder.

SCHEDULE: 2000 - 2002

NOTES:

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: ADS-00-5

TITLE: Temperature and dissolved gas exposure of adult salmon and steelhead migrants and the effects of water quality on survival and reproductive success.

FISH PROGRAM FEATURE: System - Adult Passage

PROBLEM STATEMENT: Adult salmon and steelhead migrating to their natal streams in tributaries of the Columbia River must pass up to eight or nine dams; four dams each in the lower Columbia and Snake rivers, and five in the mid Columbia River. Adult migrants may encounter high river temperatures or supersaturated dissolved gasses en route to their spawning grounds. High temperatures may reduce reproductive success, increase susceptibility to disease, accelerate loss of energy reserves, extend passage delay and elevate stress of adult salmon and steelhead. Exposure to high levels of supersaturated dissolved gasses can be fatal to adult salmonids. It is not known whether adult migrants are able to avoid areas of high temperatures or supersaturated gasses or how these variables affect their reproductive success.

BIOP MEASURES: This evaluation is included under Reasonable and Prudent Alternatives (RPA) 34 and 115 in the NMFS 2000 Biological Opinion for Operation of the Federal Columbia River Power System.

OBJECTIVES:

1. Determine whether cool water releases from Dworshak affect migration patterns of adult salmon and steelhead.
 - a. Map cool water corridors created by water releases from Dworshak.
 - b. Determine migration routes of summer and fall chinook and steelhead that are tagged with radio-transmitters as they travel above Lower Granite Dam to tributary mouths.
 - c. Determine whether migration routes are associated with cool water corridors.
2. Determine whether known source Snake River spring chinook tagged with radio transmitters and depth recorders avoid gas-supersaturated water - placeholder pending results of 2000 study.
3. Determine whether exposure to elevated river temperatures is related to interdam loss or mortality – placeholder pending results of 2000 study.
4. Determine whether exposure to supersaturated gas is related to interdam loss or mortality – placeholder pending results of 2000 study.

SCHEDULE: 2000 - 2002

NOTES:

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-00-6

TITLE: Evaluation of Kelt Passage through Columbia and Snake River Dams.

FISH PROGRAM FEATURE: System - Adult Passage

PROBLEM STATEMENT: Unlike chinook, sockeye and coho salmon, steelhead trout may spawn more than once during their lifetime. In the Columbia Basin, post-spawn steelhead (kelts) must first pass up to nine dams on their return to the ocean. Ultrasonic identification and enumeration work conducted in 1999 and 2000 have estimated 80% to 90% of the steelhead passing through the Lower Granite and Little Goose juvenile fish facilities are kelts, but it is not known what proportion or number of them survive through the FCRPS to below Bonneville. By tagging kelts and monitoring their migration downstream through the FCRPS, we could gain a better understanding of routes of passage and survival of kelts. This will provide basic abundance and survival information needed to develop effective protection measures for these fish.

BIOP MEASURES: This evaluation is included under Reasonable and Prudent Alternative (RPA) 109 in the NMFS 2000 Biological Opinion for Operation of the Federal Columbia River Power System.

OBJECTIVES:

1. Enumerate downstream kelt passage and run timing through the Snake and Columbia rivers. (2000 – 2001)
2. Estimate kelt abundance in the juvenile collection systems and the Snake and Columbia rivers. (2000 – 2001)
3. Determine passage routes, distribution and survival through each route for kelt. Investigate the use of telemetry as a methodology (2001 – 2002)
4. Evaluate system survival (Lower Granite to McNary and to Bonneville dams). (2001-2002)
5. Monitor fish condition and collect scale or fin ray samples to determine life history information from individually tagged kelts. (every year of field work)
6. Investigate and evaluate protection measures, including operational changes, collection and downstream transportation, and/or collection and reconditioning in a fish culture facility. (2002 – 2004)

SCHEDULE: 2000-2004

NOTES: Preliminary results of a BPA funded study indicate that more than 50% of kelt held for reconditioning may survive and remature.

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: ADS-P-00-8 (formerly MPE-99-1)

TITLE: Development of Alternative Means to Pass Adult Pacific Lamprey Around Dams

FISH PROGRAM FEATURE: System - Adult Passage

PROBLEM STATEMENT: There is significant regional concern regarding lamprey populations in the Columbia Basin. In 1993, the Oregon Department of Fish and Wildlife designated Pacific lamprey at risk of being listed as threatened or endangered. The U.S. Fish and Wildlife Service designated Pacific lamprey as a Category 2 candidate species in 1994. The Northwest Power Planning Council's (NPPC) 1994 Fish and Wildlife Program acknowledged the apparent decline of Pacific lamprey and requested a status report to identify research needs. Columbia River treaty tribes have repeatedly voiced concern about the decline of Pacific lamprey, a culturally important species.

Radio telemetry data indicate adult lamprey have a low passage success rate at Bonneville Dam (~40% of all fish released below the dam successfully pass). These data also identify entrances, entrance pools and count stations as the primary obstacles to lamprey passage. In 2000 we evaluated the effect of floor diffusers, count stations, lighting, and entrance head on lamprey passage. We found that diffuser gratings affected lamprey passage but lighting did not. In the test ladder, passage improved when steel strips or runways over part of the diffuser gratings were provided for lamprey to attach to. The entrance head test was started too late to provide adequate sample sizes. We also made some minor modifications to the surfaces around one spillway entrance, and this seemed to improve passage success. The goal of this program is to develop upstream migrant facilities at Bonneville that will pass adult Pacific lamprey without disrupting adult salmon and steelhead passage. In 2001 we will evaluate the effect of a steel runway along the Washington shore fishway collection channel diffuser grating. We will also repeat the entrance head test and modify another spillway entrance. Since count station lighting did not appear to hinder lamprey passage we will intensively monitor the area around the count window to attempt to isolate the cause of poor passage there. We may require additional testing with the experimental ladder in 2002 to further identify the cause of poor passage success at upper ladder sections, and/or evaluate passage facility concepts under consideration in the design phase of the program.

BIOP MEASURES: Pacific lamprey are not listed under the Endangered Species Act.

OBJECTIVES:

1. Evaluate modifications to adult fishways that would pass Pacific lamprey.
2. Assess the effect of modifications on adult salmon and steelhead passage.

SCHEDULE: 1999 - 2003

NOTES:

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: ADS-P-00-9 (formerly MPE-98-2)

TITLE: Effects of Swimming and Exhaustive Stress in Pacific Lamprey: Implications for Upstream Migrations Past Dams.

FISH PROGRAM FEATURE: System - Adult Passage

PROBLEM STATEMENT: There is significant regional concern regarding lamprey populations in the Columbia Basin. In 1993, the Oregon Department of Fish and Wildlife designated Pacific lamprey at risk of being listed as threatened or endangered. The U.S. Fish and Wildlife Service designated Pacific lamprey as a Category 2 candidate species in 1994. The Northwest Power Planning Council's (NPPC) 1994 Fish and Wildlife Program acknowledged the apparent decline of Pacific lamprey and requested a status report to identify research needs. Columbia River treaty tribes have repeatedly voiced concern about the decline of Pacific lamprey, a culturally important species. Before lamprey population decline can be adequately addressed, fundamental biological questions must be answered, including identification of the biological and ecological factors affecting lamprey production in the Columbia River Basin. One limiting factor for lamprey production may be the metabolic costs and potential detrimental effects of dam passage.

BIOP MEASURES: Pacific lamprey are not listed under the Endangered Species Act.

OBJECTIVES:

1. Using telemetered electromyograms and laboratory derived information, assess the metabolic costs of wild Pacific lampreys as they move through the upstream fish passage facilities at Bonneville Dam.
2. Assess the effects of exhaustive stress on selected aspects of Pacific lamprey reproductive performance.

SCHEDULE: 1999 - 2003

NOTES:

**North Pacific Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: ADS-00-13

TITLE: Effects of Dam Passage on Survival and Reproductive Fitness of Adult Salmon and Steelhead

FISH PROGRAM FEATURE: CRFMP - System

PROBLEM STATEMENT: Adult salmon and steelhead migrating to their natal streams in tributaries of the Columbia River must pass up to eight or nine dams : four dams each in the lower Columbia and Snake rivers, and five in the mid Columbia River. While studies have documented direct mortality due to factors such as fallback at these dams, little is known regarding delayed effects of dam passage on adult migrant survival and reproductive success. Excessive energy expenditure and exposure to adverse water quality are elements of dam passage that may have a delayed effect on adult salmon and steelhead survival and reproductive fitness.

BIOP MEASURE: This evaluation is included under Reasonable and Prudent Alternative (RPA) 118 in the NMFS 2000 Biological Opinion for Operation of the Federal Columbia River Power System.

OBJECTIVES:

1. Assess the metabolic costs of migration and the potential detrimental effects of dam and reservoir passage.
 - a. Develop relations between telemetered electromyograms, oxygen consumption, tail beat frequency, and physiological indicators of stress in adult spring chinook salmon.
 - b. Estimate the amount of energy expended during upstream migration past dams and through reservoirs.
 - c. Evaluate potential effects of dam passage on survival and reproductive success.
2. Assess the effect of high water temperatures on energy expenditure, survival, and reproductive success.

SCHEDULE: 2000 - 2003

NOTE:

**Northwestern Division – Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: ADS-00-14 *Placeholder*

TITLE: Adult Salmonid Behavior and Passage Routes Within Adult Fishways Associated with the Adult PIT Tag Evaluations Program.

FISH PROGRAM FEATURE: CRFMP - Bonneville

BIOP MEASURE: Per the National Marine Fisheries Service (NMFS), Biological Opinion (RPA 50) the Portland District, Bonneville Power Administration, and NMFS have undertaken an adult PIT tag monitoring research and development program. In 1999 & 2000, several underwater orifices within adult fishways at the Bonneville project were modified to install developmental PIT tag readers. Further, the Corps and NMFS are undertaking a hydraulic modeling program to better evaluate hydraulic conditions associated with these and other possible modifications to adult fishways to insure proper fish passage conditions. It will be necessary to also study fish passage behavior and timing during the development of this monitoring technology. Work in 2001 will continue the video evaluation of adult salmonid behavior associated with underwater orifice passage, and passage over the overflow weirs. This work will be conducted with BPA funded fish studies of efficiency for passage through underwater orifices outfitted with PIT tag detection antenna and transceivers.

OBJECTIVES:

1. Conduct adult salmonid underwater video, and visual tag studies to assess fish behavior and passage for areas modified for PIT tag detection.
2. Conduct adult salmonid underwater video, and visual tag studies to assess fish behavior and passage for areas of overflow weir passage.

SCHEDULE: 2000- 2003

NOTE: The study has been included as a placeholder. The current plan is for adult PIT detection within all adult fishways at Bonneville lock and dam by 2002, and the need for further field evaluations is unclear at this time.

**North Pacific Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: ADS-02-15 (previously objective 2 under ADS-00-3)

TITLE: Evaluation of Adult Salmon and Steelhead Headburn at Columbia and Snake River Dams

FISH PROGRAM FEATURE: CRFMP - System

PROBLEM STATEMENT: 'Head burn' is a term used by biologists to describe certain lesions found on the head of adult salmonid migrants observed at Columbia and Snake River hydroelectric projects. These lesions typically involve exfoliation of skin and underlying tissue of the jaw and cranial region. Since the 1970's this condition has been observed, and is typically more prevalent during years with high river flows and spill. To date, the cause of head burn and its effect on survival is unknown, but two primary hypotheses exist: 1.) head burn is a result of exposure to gas supersaturated water, 2.) head burn is a result of mechanical injury (i.e. striking a spillgate during fallback). A recent laboratory study on the effects of pressure and dissolved gas on turbine-passed fish produced head burn-like symptoms on juvenile rainbow trout. Controlled laboratory studies that expose adult salmonids to environmental conditions present at dams, such as supersaturated dissolved gas and pressure changes may help further address these hypotheses.

BIOP MEASURE: This evaluation is included under Reasonable and Prudent Alternative (RPA) 108 in the NMFS 2000 Biological Opinion for Operation of the Federal Columbia River Power System.

OBJECTIVES:

1. Evaluate potential causes of headburn by exposing adult salmonids to gas supersaturated water, pressure changes, and other environmental conditions that adult migrants may encounter during dam passage.
2. Assess the association between migration history and headburn by monitoring radio-tagged adult salmonids at Lower Granite Dam.

SCHEDULE: 2002-2005

NOTE:

**North Pacific Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY**

STUDY CODE: ADS-02-New

TITLE: Evaluation of Marine Mammal Predation Below Bonneville Dam

FISH PROGRAM FEATURE: CRFMP - System

PROBLEM STATEMENT: Numerous salmonids enter the Columbia River system with marine mammal wounds. Some additional predation occurs at Bonneville Dam, where sea lions have been observed each spring for many years. The Oregon Department of Fish and Wildlife (ODFW) found that 36.5% of a sample of 203 steelhead observed at Bonneville Dam in 1994 had marine mammal injuries. At Lower Granite Dam, marine mammal bite marks have been monitored since 1990, and spring and summer chinook injury rates were 19.2%, 14.0%, 15.0%, and 18.3% for 1990-93. The proportion of these injury rates attributable to sea lions in Bonneville Dam's tailrace is unknown. Also unknown is the effect marine mammal injuries have on adult migrant survival or spawning success.

BIOP MEASURE: This evaluation is included under Reasonable and Prudent Alternative (RPA) 106 in the NMFS 2000 Biological Opinion for Operation of the Federal Columbia River Power System.

OBJECTIVES:

1. Develop standards for monitoring at FCRPS count stations. 2002
2. Analyze existing and future adult telemetry data to determine whether any tagged fish are preyed upon by marine mammals in Bonneville's tailrace. 2002-2005
3. Determine seasonal timing and numbers of Pinnipeds present at Bonneville Dam. Start with available data. Conduct additional monitoring if needed. 2002-2003
4. Estimate Pinniped consumption of adult salmonids at Bonneville Dam. 2002-2003
5. Identify individual Pinnipeds at Bonneville Dam and determine whether they return in subsequent years 2002-2005.
6. If warranted, identify potential control measures. 2004 - 2005

SCHEDULE: 2002-2005

NOTE:

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
STUDY SUMMARY**

STUDY CODE: EST-02-01

TITLE: A Study To Estimate Salmonid Survival Through The Columbia River Estuary Using Acoustic Tags.

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FISH PROGRAM FEATURE: CRFMP – Estuary Program

BIOP MEASURE:

The Columbia River estuary is considered critical to the survival and fitness of juvenile salmon migrating to the ocean. Understanding estuarine survival of different runs of juveniles with different passage histories is critical in understanding all the factors that effect juvenile salmon. Development of a tag small enough to use in sub-yearling chinook is vital to determining this survival.

OBJECTIVES:

4. Develop a acoustic tag that is small enough to use in subyearling juveniles. Research and development is needed in the following areas.
 - b. Downsizing existing tag and reducing density so they can be used in sub-yearling fish.
 - c. Downsizing the battery system to use with the tag.
5. Analyze the acoustic climate at the Mouth of the Columbia River and develop appropriate detection arrays to monitor juvenile survival.
6. Conduct preliminary test of the tag and detection arrays.
7. Evaluate juvenile survival though the estuary by tagging a variety of treatment groups with different passage histories.(2002-2004).

SCHEDULE: 2000-2004

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
STUDY SUMMARY**

STUDY CODE: EST-02-02

TITLE: Estuarine Habitat And Juvenile Salmon – Current And Historic Linkages In The Lower Columbia River And Estuary

FISH PROGRAM FEATURE: CRFMP - Estuary

BIOP MEASURE:

Understanding how juvenile salmon use of the Columbia River estuary in regards to rearing is vital to understanding the factors that effect their survival. Little information is available on which habitats are important, why they are important, and how they are used and for how long. This research will provide information that can be used to answer these questions.

OBJECTIVES:

- 1) Continue monthly monitoring of use of estuarine habitat by juvenile salmon
- 2) Continue developing linkages between juvenile salmon and habitat attributes that determine juvenile salmon use and performance in estuarine habitats, with a focus on tidal and forested wetlands
- 3) Continue development of a GIS-based salmon habitat map of the lower Columbia River and estuary (2002-2003)
- 4) Continue developing monitoring stations to continuously measure the physical oceanographic environment in support of the biological studies in the Columbia River estuary
- 5) Further refinement of the historical database of flows and sediment input into the lower river and estuary (this will be completed during the second year)
- 6) Initiate studies to characterize the role of sediment input into the estuary as a factor affecting habitat creation and use and performance (growth) of juvenile salmon of estuarine habitat in the lower Columbia River and estuary
- 7) Develop a 3-dimensional model of the lower Columbia River and estuary that will be used to evaluate the historical, current and future habitat opportunity for juvenile salmon.

SCHEDULE: 2000-2005

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
STUDY SUMMARY**

STUDY CODE: EST-02-03

TITLE: Evaluation Of The Relationship Among Time Of Ocean Entry, Physical, And Biological Characteristics Of The Estuary And Plum Environment And Adult Return Rates.

FISH PROGRAM FEATURE: CRFMP-Estuary

BIOP MEASURE:

This study will examine the relationship among time of salmonid ocean entry, physical and biological characteristics of the Columbia River estuary and nearshore plume environment, and smolt-to adult return rates (SARs) for yearling chinook and/or coho salmon.

OBJECTIVES:

3. Estimate smolt-to-adult-returns of serially released yearling chinook and/or coho salmon through the spring migration period.
4. Characterize variations in the physical and biological conditions in the Columbia River estuary and nearshore ocean environment during this time period.
5. Determine the level of physiological development and disease status of smolts at release.
6. Correlate SARs with environmental conditions.
7. Identify potential indicators (biotic, abiotic, or a combination of both) of salmonid marine survival that could be used to improve management actions.

SCHEDULE: 2000-2004

**Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
STUDY SUMMARY**

STUDY CODE: EST-02-04

TITLE: Distribution And Abundance Of Coastal Cutthroat In The Columbia River Estuary

FISH PROGRAM FEATURE: CRFMP – Estuary

Relatively little is known about how sea-run cutthroat trout use estuaries and how modifications in estuarine habitat may affect the species. The habitat available to cutthroat trout within the estuary has been modified through alterations in the flow regime by federal hydropower facilities. Reductions in the quality and quantity of estuarine habitat are a likely contributor to the observed declines in cutthroat trout populations in the Columbia River, though this relationship is not well understood. As this species is proposed for listing under the Endangered Species Act, it is critical that we further investigate the role of the estuary in the life history of cutthroat trout.

BIOP MEASURE: NA

OBJECTIVES:

1. Review historical data collected by various state and federal agencies that have conducted research in the lower Columbia River estuary. These records will be queried to determine historical areas of high use by cutthroat trout. Catch from research vessels currently fishing the lower Columbia River estuary will be monitored to establish current areas of high use and locations of recapture.
2. Sample in the areas of high use by cutthroat trout, as determined during Objective 1 and continue monitoring catch from other research vessels. Cutthroat trout captured within the estuary and from the monitored tributaries will be fitted with an internal radio tag and their patterns and timing of migration will be monitored.
3. Scales will be collected during Objective 2 and aged and used for strontium analysis. All data collected of a geographic nature will be entered into a Geographic Information System (GIS) for archival and spatial analysis purposes

SCHEDULE: 2001-2004